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FRIDAY, APRIL 8, 1898.

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THE MATHEMATICAL THEORY OF THE TOP.*

LOOKING over such famous old books as Montmort's 'Analyse des jeux de hasard' or Moivre's 'Doctrine of Chances' one regrets that so much excellent mathematics should have been wasted on games most of which are wholly obsolete. Coriolus in his 'Jeu de billard' (1835) fared better, for the game is still very much alive and its dynamical terrors unsubdued. In even greater measure is this true of the top. The top has been everybody's toy and must, therefore, at one time or another have piqued everybody's curiosity. Lagrange, Poincaré, Jacobi, not to mention other great names, have in their turn paid tribute; yet the top may be set spinning to-day, unhampered by a completed theory to account for its evolutions.

Among recent contributions we may refer in particular to Professor A. G. Greenhill's† noteworthy papers, in which the algebraically accessible or pseudo-elliptic cases, such in which the integrations are possible in terms of circular functions, are worked out in full. Physicists will be grateful to Professor Greenhill for the concrete exhibition given of this complex motion. The

* Lectures delivered on the occasion of the sesquicentennial celebration of Princeton University, by Felix Klein, pp. 1-74, edited by Professor H. B. Fine. New York, Charles Scribner's Sons, 1897.

† Greenhill: Applications Elliptic Functions, Proc. Lond. Math. Soc., 1895, 1896; *Engineering*, July, 1896.